Advances in SAR

for keeping targets at risk

NDIA 2002

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Overview
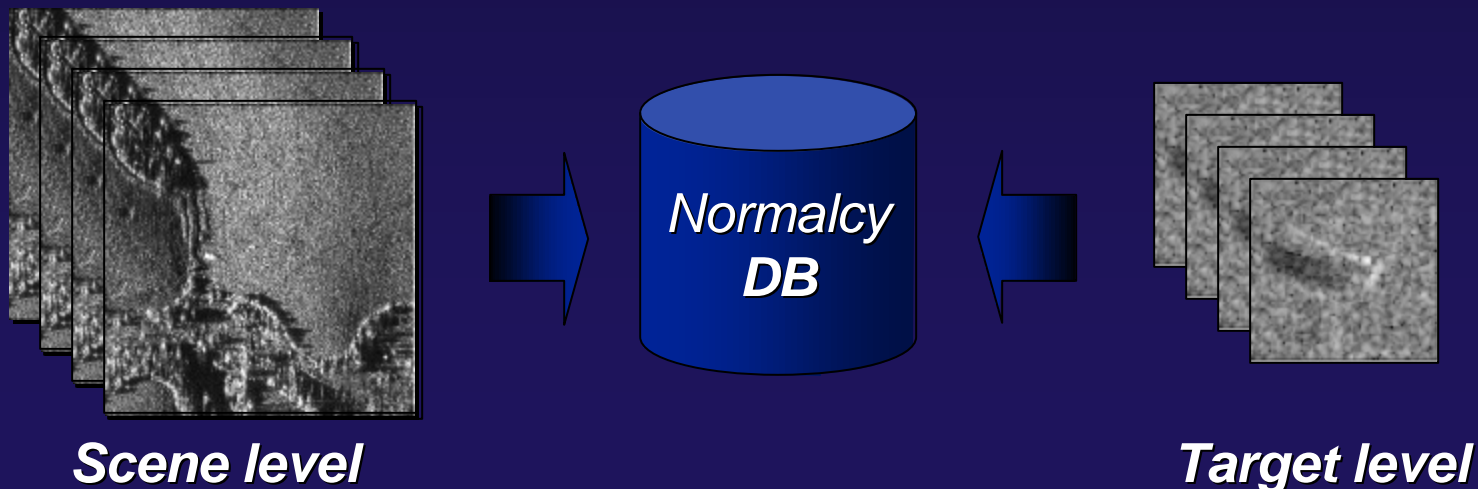
- **SAR-Based Change Detection**
  - Normalcy concept
    - Scene level
    - Target level
- **Wide area target detection**
  - Object-Level CD
- **Detecting evidence of target movement**
  - Coherent CD
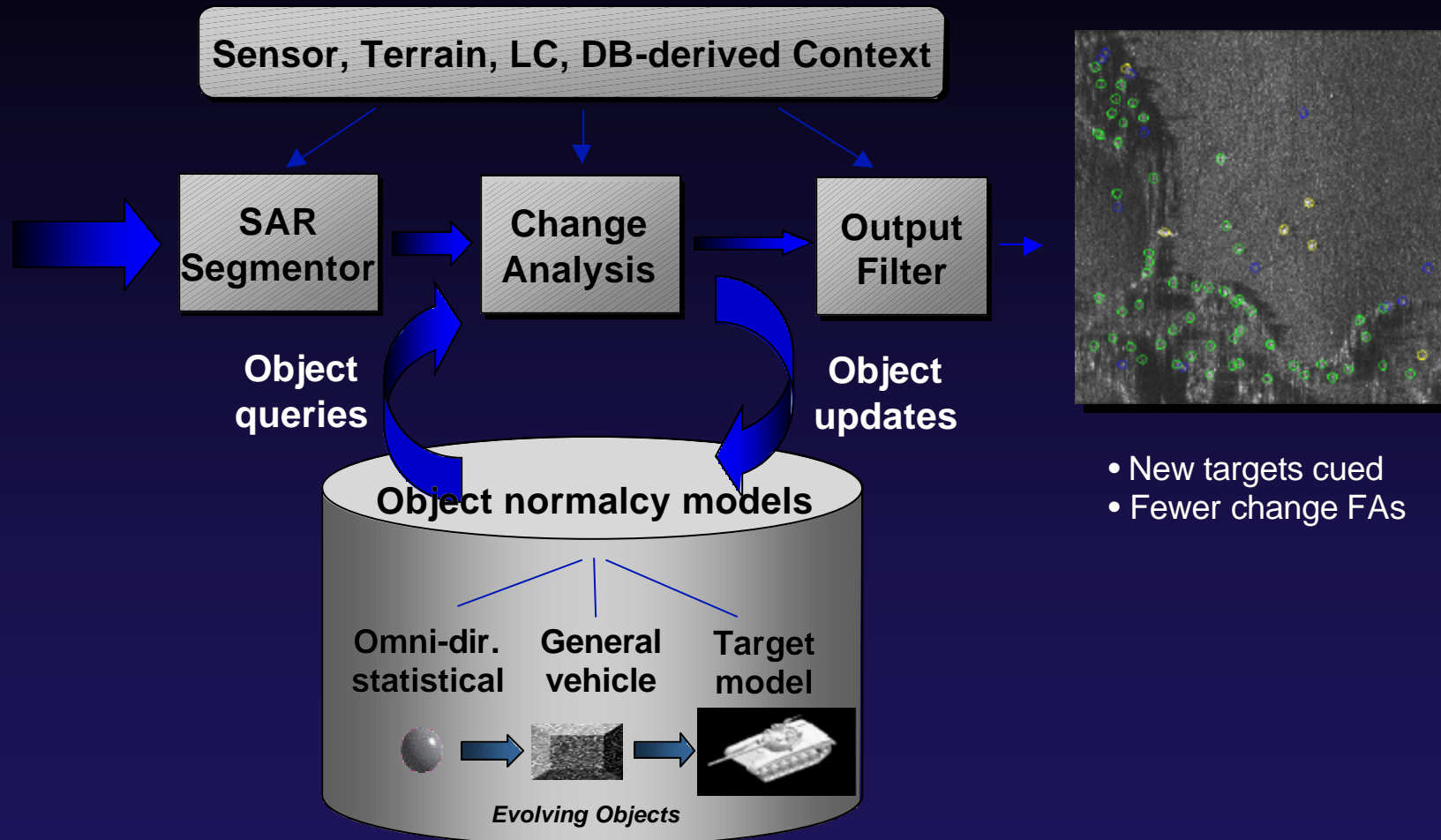- **Detecting changes in targets**

Normalcy

- **Historical representation of an area or an object that provides a basis for declaring significant change**
  - Pixel level (coherent CD, image compare)
  - Object level (OLCD)

*Normalcy DB*

Scene level

Target level

SAR OLCD

Sensor, Terrain, LC, DB-derived Context

SAR Segmentor → Change Analysis → Output Filter

Object queries

Object updates

Object normalcy models

Omni-dir. statistical → General vehicle → Target model

Evolving Objects

- New targets cued
- Fewer change FAs

- **SAR OLCD detects changes via object association**
- **Application: target deployment detection**

OLCD Example

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- **May 7 database scene**
  - 3 existing vehicles
  - Significant tree and bush clutter (tree lines)
  - Reflectors

DB Objects
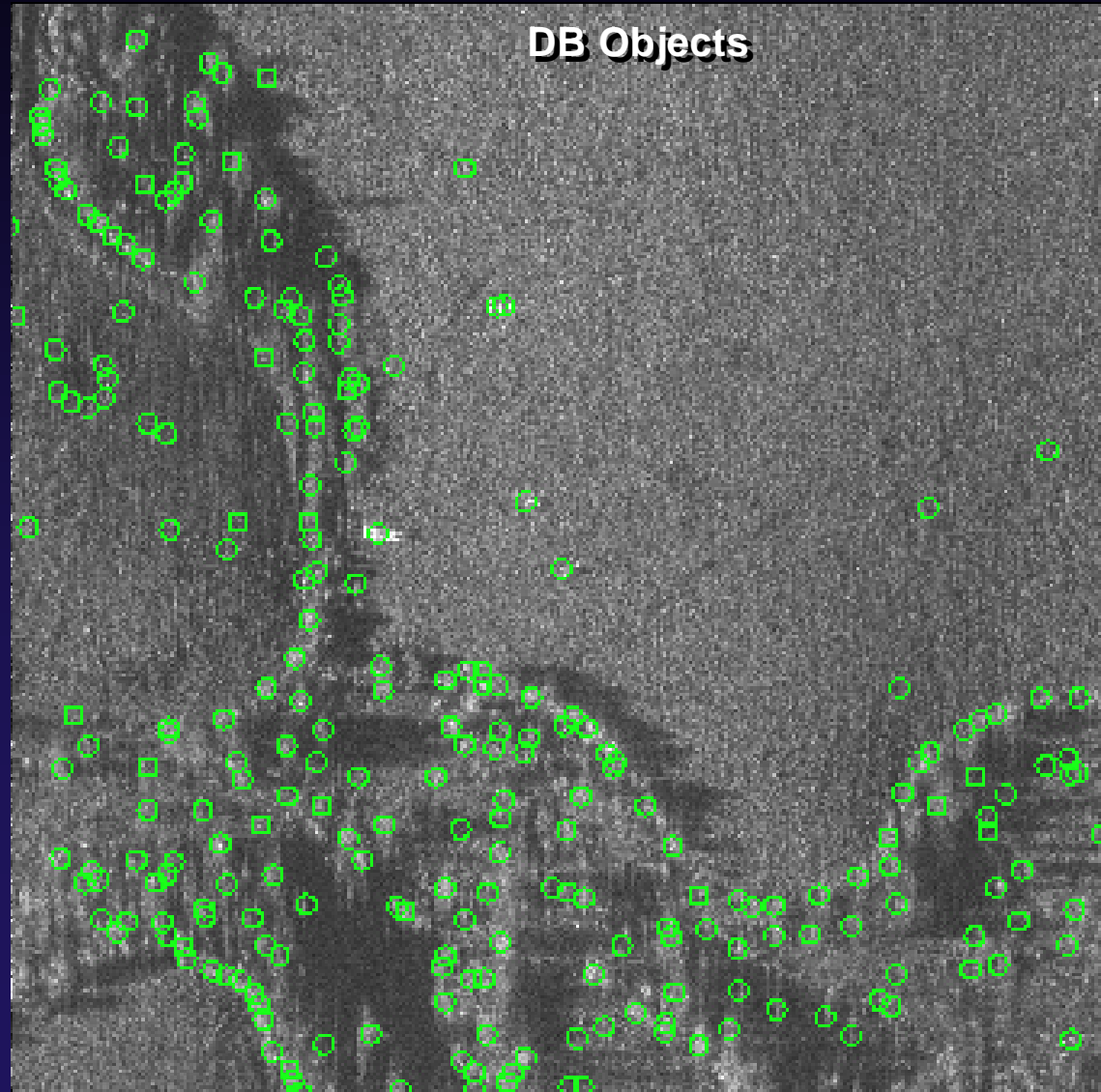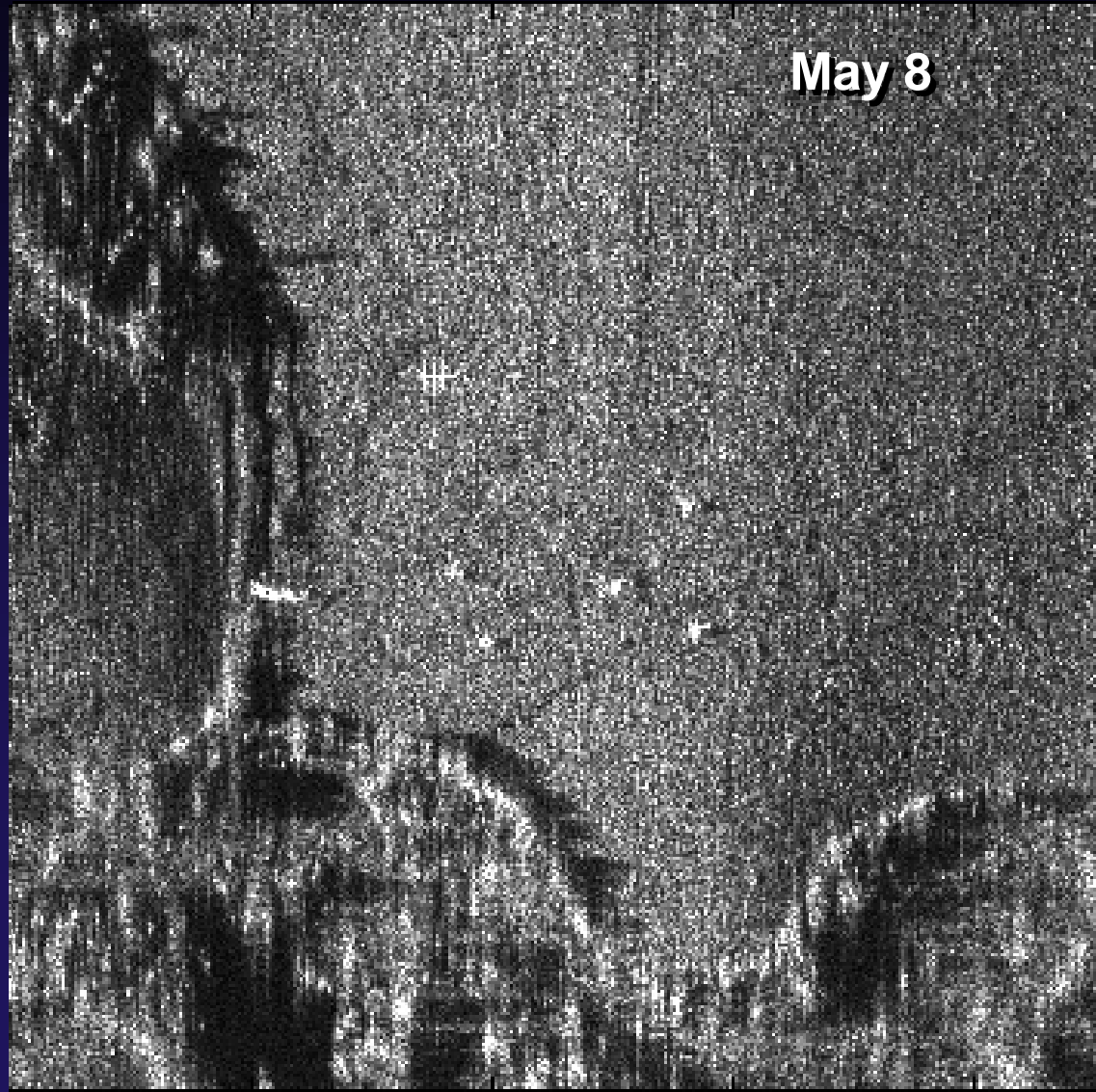
New Vehicles Deployed

■ **Database Scene**

- 3 existing vehicles
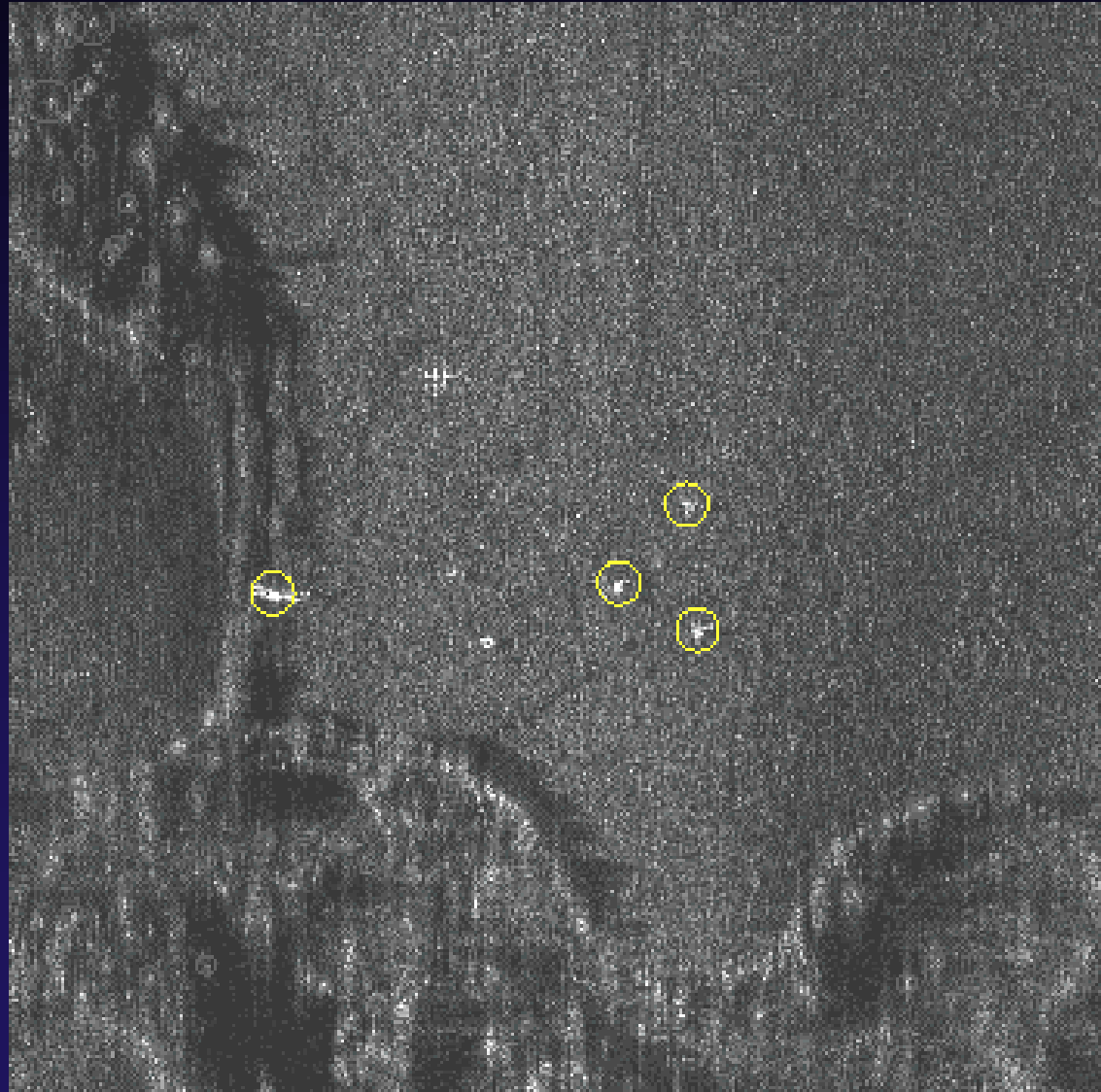- Significant tree and bush clutter (tree lines)
- Reflectors

■ **New Scene**

- 2 existing vehicles
- 3 new targets
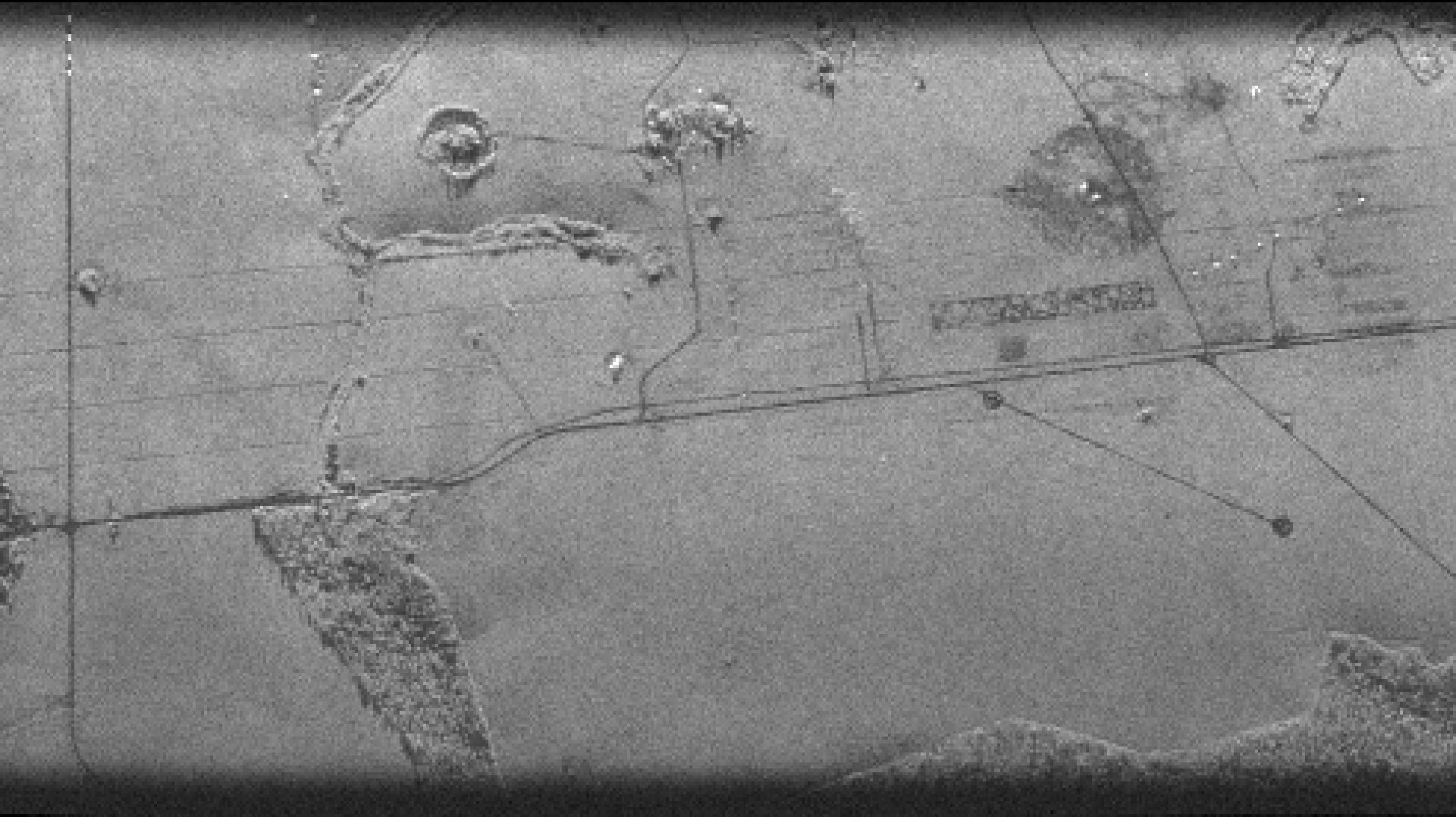- 1 moved & deployed target (bridger)

May 8

Detected Changes

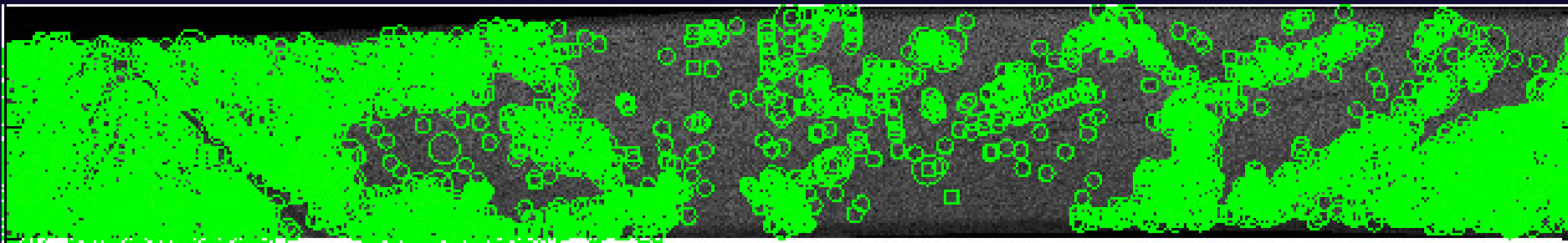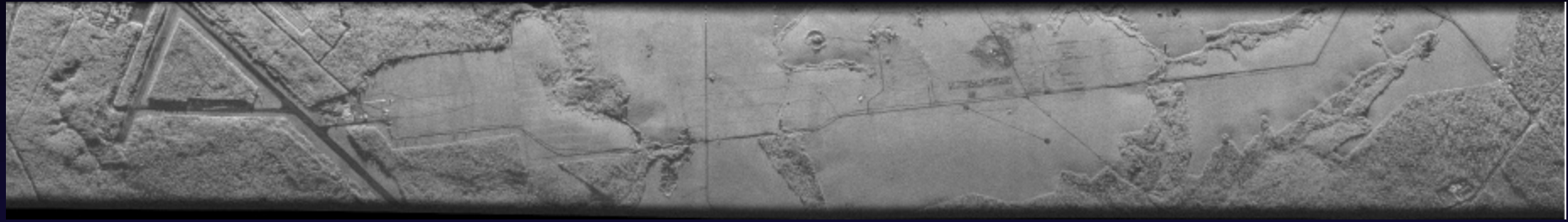- **Center large yellow circles denote new unassociated objects target-sized**
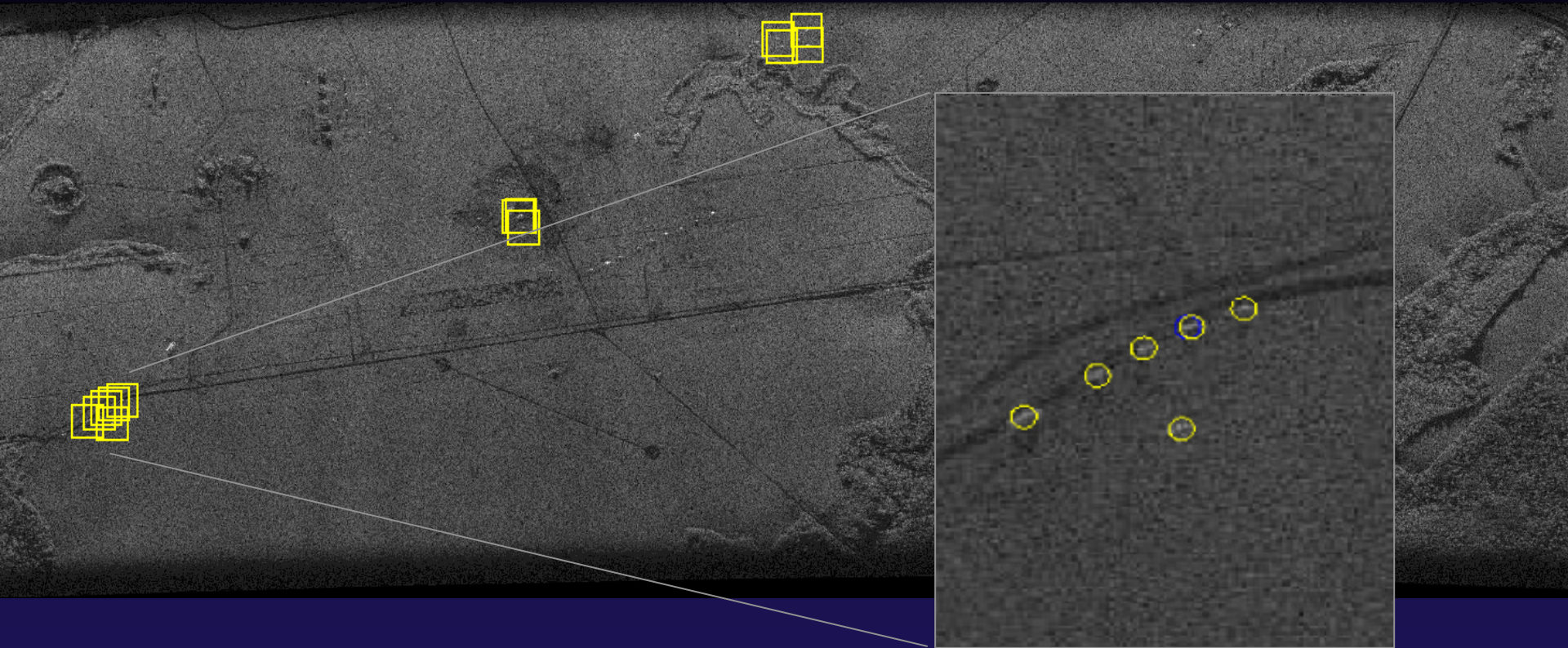
Wide Area Detection

Numerous instantances of pre-existing manmade clutter

Wide Area Screening

- **Database populated with numerous objects (manmade and natural)**

Wide Area Screening

- **Detected new vehicle deployments**
  - Highly sensitive to new appearances
  - Low false alarms for vehicle groups

Coherent Change Detection

- **Two-pass coherent processing**
  - Coherent change detection using complex imagery
  - Best complex image (in terms of flight path) used as normalcy reference
- **Application: vehicle change detection and ground disturbance**

SAR Images and CCD

Location: Kirtland housing area

Sensor: Sandia experimental "Strip" radar

vehicle

INITIAL IMAGE

CCD MAP

vehicle

IMAGE AFTER VEHICLE MOVEMENT

Vehicle shows up as change in the CCD map
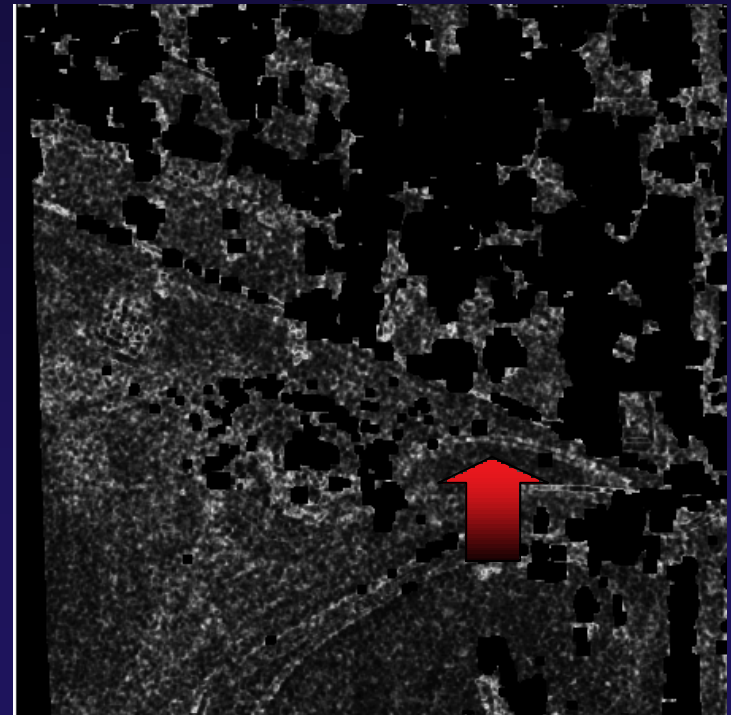
Vehicle off-road tracks

Noise Reduced
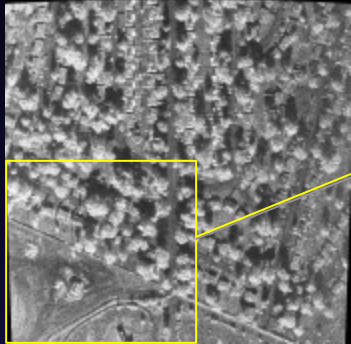
• Processed Area

■ Telltale vehicle track

• CCD image
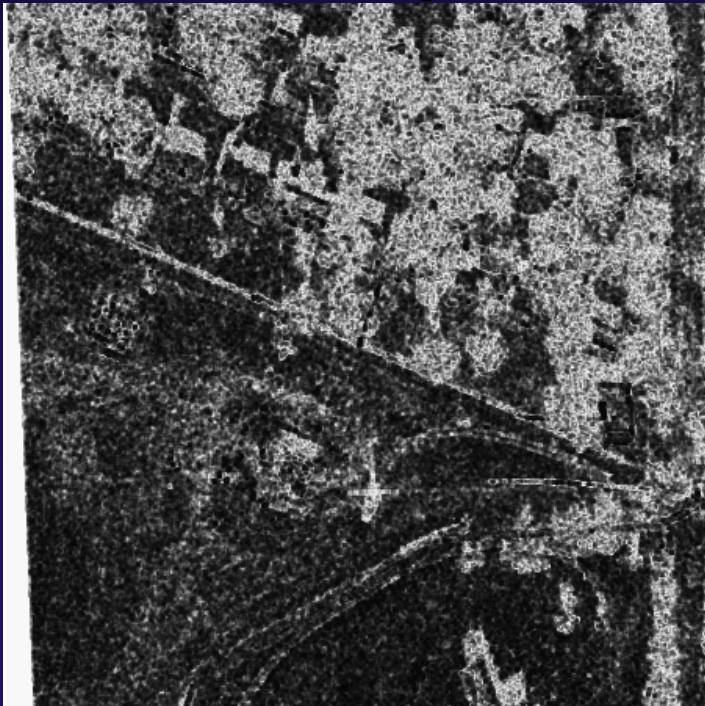
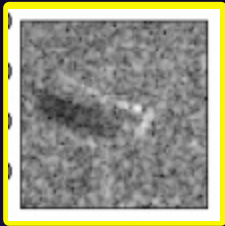• Random phase attenuated

Vehicle Level Change

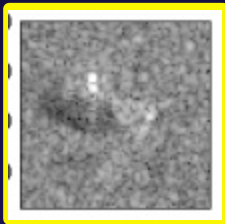# Physical Changes

Image Magnitude CFAR Change Statistic

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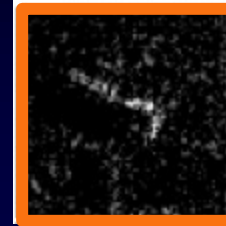
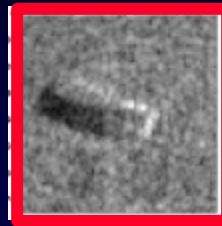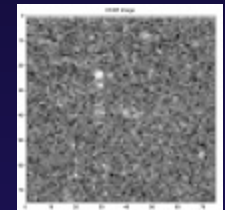**Pre & Post Damage
Test Images at same angle**

Change Statistic

Change Statistic surfaces

Pre

Post

$$\frac{X - m}{s}$$
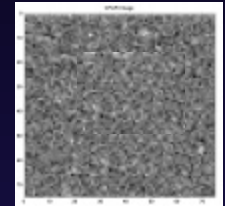
Test Van

Radar angles
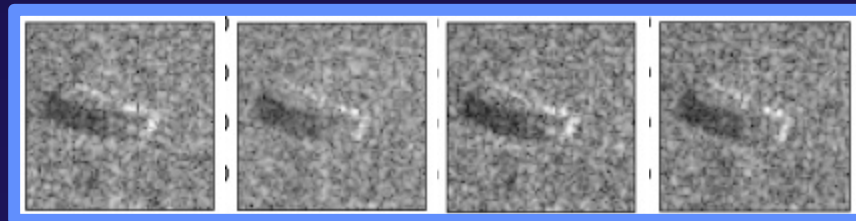
**Normalcy Images (range of angles)
(excluding test angle)**

Moderate Changes

Severe Changes

Depression:10 CFAR:3 Channel:1 Mode:3 Normal to Normal (Green) – Normal to Post (Red)
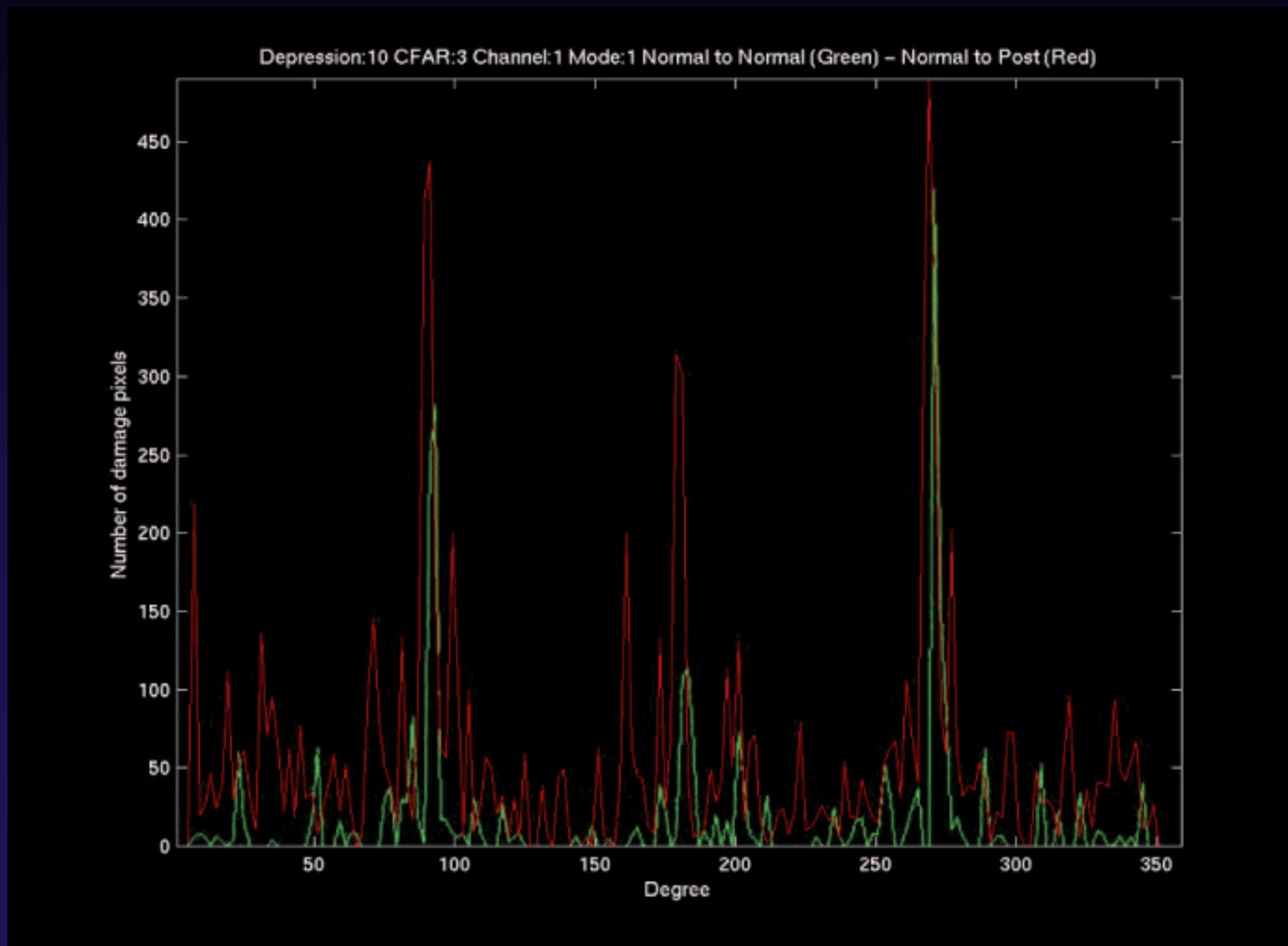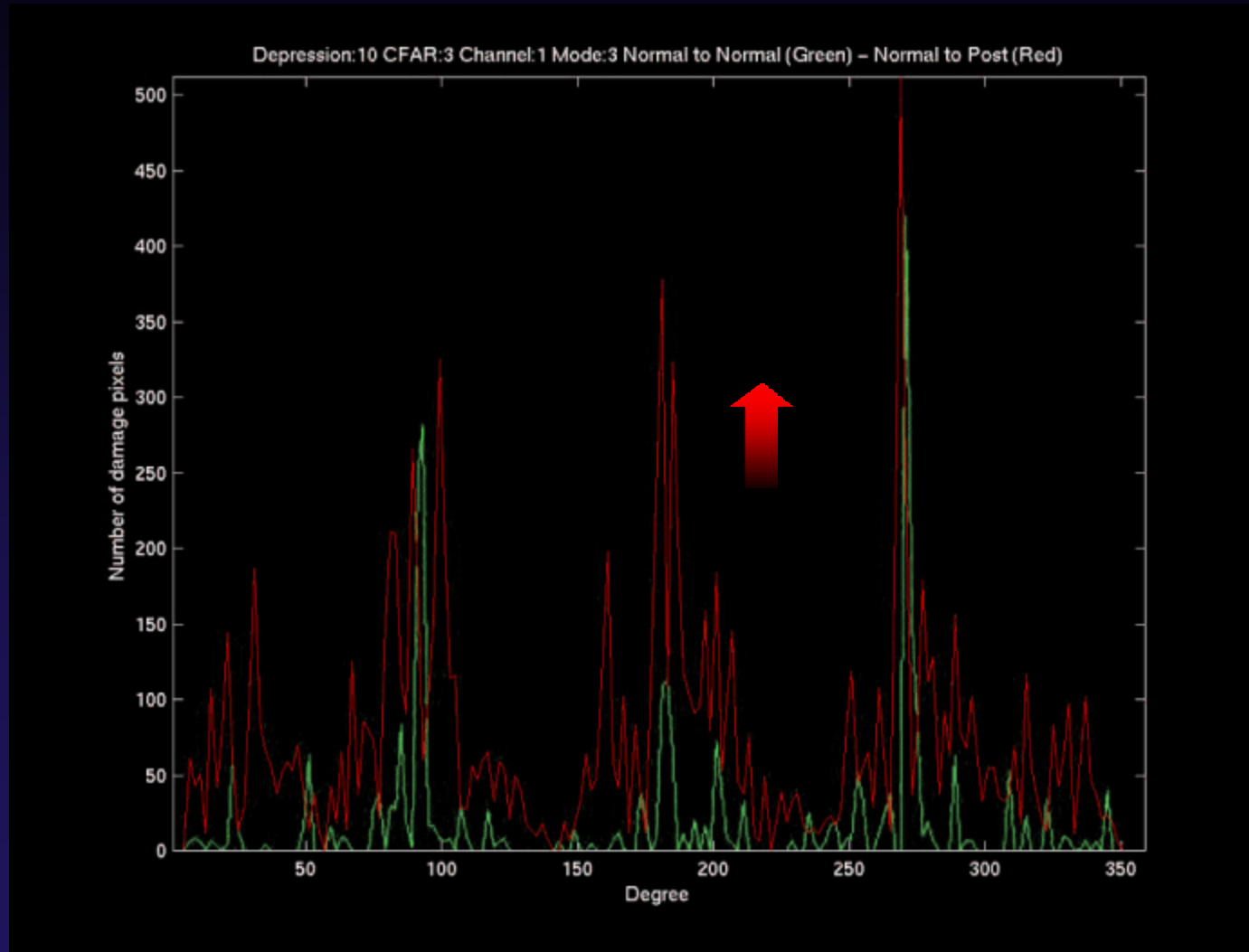
Summary

- **Use of SAR Imagery for change detection**

- **Object and pixel level**

- **Incoherent and Coherent approaches**

- **Scene and target level changes**